

Exploring Immersive Micro-Vacations and Their Efficacy on Multiple Biometric
Markers and Productivity as A Novel Therapy for Short and Long Term
Stress and Anxiety Management/Reduction:
(Technical Paper)

Virtual Reality & the Opioid Crisis
(STS Paper)

A Thesis Prospectus Submitted to the
Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia
In Partial Fulfillment of the Requirements of the Degree
Bachelor of Science, School of Engineering

Vy Lan Tran

Fall 2019

Technical Project Team Members:

Bailey Biber
Max Dodge
Melanie Gonzalez
Raymond Huang
Liv Johnson
Zach Martin
Amanda Sieger
Sophia Xiao

Approved by Laura Barnes, Department of Systems Engineering

Approved by Kent Wayland, Department of Engineering and Society

General Research Problem:

How is virtual reality being explored as a therapeutic clinical tool in today's healthcare system?

Patients are now seeking non-traditional approaches to clinical therapy that are safer, more economical, and more efficient. This demand results from widespread issues such as rising healthcare costs and the ongoing opioid epidemic. One technological approach that is receiving much recognition for its potential within the healthcare industry is virtual reality therapy. Once only used for entertainment purposes, VR has recently been repurposed into the healthcare space. Interestingly, large companies have made adding more virtual care solutions the top initiative for tackling health care costs in 2019 (Miller, 2018). VR technology serves as a relevant, attractive potential solution in that it recently emerged in the mass market with the invention of VR headsets, allowing it to be widely accessible at a reasonable cost. Ultimately, the capstone project and STS project seek to explore the emergence and effectiveness of VR as a versatile therapeutic clinical tool. While the capstone project focuses on the application of VR in the emotional health space, the STS research project focuses on using VR in the treatment of physical health.

Exploring Immersive Micro-Vacations and Their Efficacy on Multiple Biometric Markers and Productivity as A Novel Therapy for Short and Long Term Stress and Anxiety Management/Reduction:

What is the effect of restorative virtual reality environments on the physiological and psychological responses of stressed working professionals?

Due to rising costs of medical and pharmaceutical treatments, employers are seeking innovative ways to manage healthcare expenses for employees and their dependents. Studies show that 42% of employees report feeling stressed at work and are linked to 15-30% greater healthcare costs. However, a much smaller portion of employees (~22%), report being able to cope with stress very well (Colligan & Higgins, 2006). Many people in the workplace struggle to manage their stress on a regular basis, thus impeding productivity and overall workplace satisfaction. Given this current situation, many employees cannot depend on their own capabilities and instead require some external aid to help reduce stress and increase productivity. Therefore, a solution that would reduce workplace stress and increase productivity would appeal to both employees and employers.

The technical project will explore the combination of Attention Restoration Theory and virtual reality (VR) technology as a novel therapy for short- and long-term stress reduction and anxiety management. Previous evidence of biometric data support that VR environments can be successful in reducing anxiety (Gorini & Riva, 2008). Traditional treatments for stress and anxiety include medications, therapy, or self-care techniques such as meditation. However, these treatments may be expensive and time consuming, and are not quick outlets for everyday stressors such as those found in the workplace, such as running meetings and presentations.

Readily accessible digital technologies, such as VR technology, may therefore be better suited for improving mental health in a workplace setting. Study participants will undergo VR micro-vacations through a virtual reality program provided by Even Health that guides them through various settings in nature. This is designed to implement Attention Restoration Theory, or the theory that nature will restore the ability to concentrate, thus reducing stress and anxiety and promoting productivity (Ohly et al., 2016). This theory is a validated approach to reducing stress in clinical settings as well as improving productivity and mitigating stress and anxiety in the workplace. The overall goal of this project is to mitigate the rising cost of healthcare for both employers and employees through implementation of innovative technologies in the workplace that ultimately help individuals build emotional strength and better manage stress and anxiety throughout their lives.

Approach

First, a literature review will be completed to understand previous research and studies conducted in this area of study. This will help the team to understand the metrics to be collected and the tests that should be performed to evaluate the efficacy of the virtual reality intervention. Pilot testing will then be performed during the months of November and December. The study will be conducted in the basement of Olsson Hall at the University of Virginia during the months of January through February. After giving informed consent, study participants will complete a task prior to the experiment that induces minor stress or fatigue. Examples of such tasks might be a puzzle, math problem, or multi-tasking activity. The participants' biometric data that measures stress will then be collected. Such metrics will be gathered through heart rate variability sensors, blood pressure gauges, and the measuring of galvanic skin response. This preliminary test will serve as baseline data to ultimately measure the efficacy of the therapy on participants. The participants will then be immersed in the client's VR booth for 5-8 minutes, where they will select a restorative environment of their choosing from 2-3 given options (i.e. beach, lake, mountaintop). Participants will be guided through a micro-vacation in which they will have the ability to experience their chosen virtual environment. Physiological changes in patients and biometric markers will be monitored and measured throughout the therapy. Afterwards, the participants' biometric data will again be collected for comparison of pre- and post-stress levels. Likewise, a post-stimuli task will be given to measure and compare productivity. Possible independent variables to change involve the use of VR or not and the variation of the VR scenarios. Lastly, possible constraints on the project may be a limited time frame to conduct the study and that the psychological and physiological responses will be measured in a short period of time. Therefore, the findings may need further validity for situations of prolonged stress.

Anticipated Outcome

After this experiment is performed, likely in the months of January and February, and the data has been collected, cleaned, and analyzed, a research paper will be produced for the SIEDS conference in mid-April. The team will present the results of the study and provide the client with a detailed analysis of the effect of the restorative VR product on multiple biometric

indicators of stress and anxiety. While much research has been done on VR restoration therapy for hospital patients, research on utilizing such therapy to decrease stress and increase productivity in the workplace has not yet been as heavily explored. Overall, this study hopes to advance and improve future knowledge in this field. The success of this innovative approach would allow employers to curb rising healthcare costs and provide an efficient, cost-effective means of therapy for the increasingly stressed employees of today.

Virtual Reality & the Opioid Crisis:

What factors are shaping virtual reality's development as a pain therapy for alleviating the opioid crisis?

The recent epidemic of the opioid crisis has created a societal stigma around traditional pain therapy methods. The prescription of opioids, once thought to be a “one size fits all” solution, has now developed significant concerns around over-usage and safety. The mortality rates for patients who become addicted to opioids are up to twenty times higher than rates for the general population (Gupta, Scott, & Dukewich, 2018). Because of this, the healthcare industry has been forced to explore alternative, innovative approaches to pain therapy. Virtual reality has recently been recognized as a potential viable alternative with its drug-free nature, wide-spread availability, and ability to distract during painful procedures.

Stakeholders in this sociotechnical system involve the patients seeking pain therapy (or patients more likely to become addicted to opioids), healthcare professionals, pharmaceutical companies, and technological innovators. Because patients' behaviors are changing rapidly with a rise in opioid addiction and misuse, technological innovators and pharmaceutical companies are now racing to find the best alternative therapy or solution in order to meet this new demand. Patients desire methods of treatment that have been proven to be safe, effective, and economical. They entrust their lives to medical professionals. On the other hand, healthcare providers must maintain their reputation by keeping up with industry and regulatory standards to limit the number of people adversely affected from their judgment. They provide the prescriptions that are subject to criticism in light of the stigma that now surrounds opioids and must adapt by suggesting new alternative approaches. Pharmaceutical companies exhibit a conflict of interest in that they not only profit from the over-prescription of opioids, but they also profit from the development of solutions for the very epidemic in which they play a major role in spreading.

Background

According to the Centers for Disease Control and Prevention, (CDC) about 68% of the more than 70,000 drug overdose deaths in the United States in 2017 involved the use of an opioid (Holly Hedegaard, Miniño, & Warner, 2019). The CDC describes the evolution of the opioid epidemic in three waves: prescription opioids, heroin, and synthetic opioids. When healthcare professionals over-prescribed pain killers, patients became addicted and later turned to heroin. According to the National Academies of Sciences (NAS), a major contributing factor to the opioid crisis concern is the rise in the availability and accessibility of heroin, which is

cheaper than prescription opioids (National Academies of Sciences, 2017). This sheds light upon the idea that though the impact of the opioid crisis is felt across nearly all sociodemographic groups, it may be affecting those more economically disadvantaged more heavily. However, the most recent cause for concern lies with the “third wave,” or synthetic opioids. From just 2016-2017, the age-adjusted rate of drug overdose deaths involving synthetic opioids such as fentanyl increased by 45% (Holly Hedegaard, Miniño, & Warner, 2019). Overall, this three-wave development of the opioid epidemic reveals a pattern that is undeniable: once a new opioid is introduced, patients become addicted, deaths increase rapidly, and users yet again turn to alternative sources of opioids.

Methods & Data Collection

In order to seriously consider the implementation of virtual reality as a clinical tool, one must understand how the opioid epidemic started in the first place. By understanding how the problem first developed, one can then identify major factors to consider that would shape the development of a potential solution such as VR pain therapy. After the paper explores such background, I foresee that the paper will have three sections of analysis: past clinical studies utilizing VR for pain management, healthcare industry influencers, and finally another section on regulation on the opioid crisis. By dividing the paper into such sections, the paper explores the roles and interactions of various actors affecting the development of this novel therapy. Specifically, the past studies section will collect evidence from secondary sources on where VR has been utilized in pain management in order to understand the technology’s evolution among different user groups and how such studies are impacting future research. Examples of such cases include the use of VR for mitigating pain in chemotherapy, physical therapy, treating burn wounds, and even routine medical procedures such as blood drawing and immunizations (Li, Montaña, Chen, & Gold, 2011). This information will be sought from recent articles from established journals, such as in the *Public Library of Science* or the *Annals of Behavioral Medicine*. These previous cases may also suggest whether VR therapy could be used in replacement of opioids, together with opioids, or not at all. The healthcare industry section will explore how medical professionals, “big pharma” companies, and insurance companies as a whole could impact the development of this technology. Finally, the regulation section will detail the influence of governing bodies from reliable sources such as the CDC, the FDA, or the White House.

Conclusion:

Overall, the capstone and STS research projects demonstrate the notable emergence of VR as a means of clinical therapy. Because the behaviors of patients are changing in that patients are seeking therapeutic methods that are even more efficient and affordable than before, alternative therapies must be explored. The capstone project addresses this problem through the conduction of a study that explores the efficacy of restorative VR on the emotional health of stressed working professionals. On the other hand, the STS project applies this problem to the current opioid crisis and investigates several factors influencing the ongoing development of VR pain

therapy. Ultimately, the goal is to help advance the knowledge of this innovative therapy in both the emotional and physical healthcare space as it is becoming increasingly considered for widespread adoption in the clinical world.

References

- Colligan, T. W., & Higgins, E. M. (2006). Workplace Stress: Etiology and Consequences. *Journal of Workplace Behavioral Health, 21*(2), 89–97.
https://doi.org/10.1300/J490v21n02_07
- Gorini, A., & Riva, G. (2008). Virtual reality in anxiety disorders: The past and the future. *Expert Review of Neurotherapeutics, 8*(2), 215–233.
<https://doi.org/10.1586/14737175.8.2.215>
- Gupta, A., Scott, K., & Dukewich, M. (2018). Innovative Technology Using Virtual Reality in the Treatment of Pain: Does It Reduce Pain via Distraction, or Is There More to It? *Pain Medicine, 19*(1), 151–159. <https://doi.org/10.1093/pm/pnx109>
- Holly Hedegaard, Miniño, A., & Warner, M. (2019, June 7). NCHS Data Brief No. 329. Retrieved October 18, 2019, from CDC website:
<https://www.cdc.gov/nchs/products/databriefs/db329.htm>
- Li, A., Montañó, Z., Chen, V. J., & Gold, J. I. (2011). Virtual reality and pain management: Current trends and future directions. *Pain Management, 1*(2), 147–157.
<https://doi.org/10.2217/pmt.10.15>
- Miller, S. (2018, August 13). For 2019, Employers Adjust Health Benefits as Costs Near \$15,000 per Employee. Retrieved October 4, 2019, from SHRM website:
<https://www.shrm.org/resourcesandtools/hr-topics/benefits/pages/employers-adjust-health-benefits-for-2019.aspx>
- National Academies of Sciences, E., and Medicine. (2017). *Pain Management and the Opioid Epidemic: Balancing Societal and Individual Benefits and Risks of Prescription Opioid Use*. <https://doi.org/10.17226/24781>
- Ohly, H., White, M. P., Wheeler, B. W., Bethel, A., Ukoumunne, O. C., Nikolaou, V., & Garside, R. (2016). Attention Restoration Theory: A systematic review of the attention restoration potential of exposure to natural environments. *Journal of Toxicology and Environmental Health, Part B, 19*(7), 305–343.
<https://doi.org/10.1080/10937404.2016.1196155>